FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL HARDWARE
NUMBER: 06-1C-0201 -X

SUBSYSTEM NAME: ARS - ARPCS

REVISION: 8 10/27/98

PART DATA

	PART NAME VENDOR NAME	PART NUMBER VENDOR NUMBER
LRU	: RV, CABIN POSITIVE PRESSURE CARLETON TECHNOLOGIES	MC250-0002-0250 2655-0001-15

EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:
CABIN POSITIVE PRESSURE RELIEF VALVE ASSEMBLY (RELIEF AND ISOLATION VALVES)

REFERENCE DESIGNATORS:

QUANTITY OF LIKE ITEMS: 2

FUNCTION:
VALVE HAS TWO SECTIONS WHICH WORK IN SERIES. THE FRONT SECTION IS A MOTOR DRIVEN BUTTERFLY VALVE AND PROVIDES ISOLATION OF THE RELIEF SECTION. THE RELIEF SECTION VENTS AT CABIN PRESSURE BETWEEN 15.5 AND 16.0 PSID TO PREVENT OVER PRESSURIZATION OF THE CABIN AND IS CAPABLE OF FLOWING A MINIMUM OF 150 LB/HR AT 16 PSID. VALVE IS MOUNTED ON THE XO 576 BULKHEAD, WITH A SINGLE O-RING SEAL (REF FMEA 01-4-CS44-1).

- APPROVALS -

EDITORIALLY APPROVED	: BNA	: J. Kimura 10-28-98
TECHNICAL APPROVAL	: VIA APPROVAL FORM	: 96-CIL-028_06-1C

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FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CRITICAL FAILURE MODE
NUMBER: 06-1C-0201-02

REVISION# 7 01/16/91 R

SUBSYSTEM: ARS - ARPCS
LRU :RV, CABIN POSITIVE PRESSURE
ITEM NAME: RV, CABIN POSITIVE PRESSURE

RS TO VERIFY MRT NAME

CRITICALITY OF THIS FAILURE MODE:1R2

FAILURE MODE:
INABILITY TO CLOSE, INTERNAL LEAKAGE (ISOLATION OR POPPET VALVE)

MISSION PHASE:

PL	PRELAUNCH
LO	LIFT-OFF
OO	ON-ORBIT
DO	DE-ORBIT
LS	LANDING SAFING

VEHICLE/PAYLOAD/KIT EFFECTIVITY: 102 COLUMBIA
: 103 DISCOVERY
: 104 ATLANTIS
: 105 ENDEAVOUR

CAUSE:
MECHANICAL SHOCK, VIBRATION, CORROSION, CONTAMINATION, PHYSICAL BINDING/JAMMING

CRITICALITY 1/1 DURING INTACT ABORT ONLY? NO

REDUNDANCY SCREEN A) PASS
B) N/A
C) PASS

PASS/FAIL RATIONALE:
A)

B)
SCREEN "B" IS N/A BECAUSE THE ISOLATION VALVE IS IN STANDBY TO PROTECT AGAINST RELIEF VALVE LEAKAGE.

C)

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- FAILURE EFFECTS -

(A) SUBSYSTEM:
LOSS OF ATMOSPHERE THROUGH RELIEF VALVE WHICH HAS AN OPENING EQUIVALENT TO A ONE-HALF INCH DIAMETER HOLE.

(B) INTERFACING SUBSYSTEM(S):
EQUIPMENT IN CABIN WOULD BE EXPOSED TO A LOWER PRESSURE UNTIL BUTTERFLY VALVE IS CLOSED.

(C) MISSION:
POSSIBLE EARLY MISSION TERMINATION - ONLY ONE RELIEF VALVE IS AVAILABLE TO RELIEVE EXCESSIVE CABIN PRESSURE.

(D) CREW, VEHICLE, AND ELEMENT(S):
NO EFFECT.

(E) FUNCTIONAL CRITICALITY EFFECTS:
FAILURE OF THE ASSOCIATED VALVE WITHIN THE SAME ASSEMBLY (ISOLATION OR POPPET) IN THE OPEN POSITION COULD LEAD TO LOSS OF CREW/VEHICLE.

- DISPOSITION RATIONALE -

(A) DESIGN:
THE VALVE BODY IS MADE OF 6061-T6 ALUMINUM, ANODIZED FOR CORROSION RESISTANCE. THE RELIEF VALVE IS A POPPET TYPE, PRESSURE COMPENSATED BY A BELLOWS, AND INCORPORATES AN ELECTRICALLY OPERATED CLOSING OVERRIDE. THE POPPET SEAL IS A PRECISION MOLDED SILICONE ELASTOMER WHICH REQUIRES A VERY LOW SEAT SQUEEZE FORCE WHILE MAINTAINING A LOW LEAKAGE RATE. SILICONE RUBBER IS AN ORGANOSILICONE OXIDE POLYMER WHICH IS CHARACTERIZED BY REMARKABLE TEMPERATURE STABILITY, CHEMICAL INERTNESS, WATER PROOFNESS, AND EXCELLENT DIELECTRIC PROPERTIES. A CAPTIVE DEBRIS SCREEN ON THE CABIN SIDE AND A FILTER SCREEN ON THE BULKHEAD SIDE OF THE VALVE PROVIDE PROTECTION FROM FOREIGN MATERIAL.

(B) TEST:
ACCEPTANCE TEST - PER ATP 2655-5. PROOF PRESSURE 24.5 - 25.5 PSIG. INTERNAL AND EXTERNAL LEAKAGE TEST AT 15 +/- .15 PSIG, 15 SCCM MAX LEAKAGE.

QUALIFICATION TEST - PER QTP 2655-5. BURST PRESSURE 32 PSIG. DESIGN SHOCK - 20G TERMINAL SAWTOOTH PULSE OF 11 MS DURATION IN EACH DIRECTION OF THREE ORTHOGONAL AXES. RANDOM VIBRATION SPECTRUM - 20 TO 150 HZ INCREASING AT 6 DB/OCTAVE TO 0.09 G**2/HZ, CONSTANT AT 0.09

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G**2/HZ FROM 150 TO 900 HZ, DECREASING AT 9 DB/OCTAVE FROM 900 TO 2000 HZ FOR 48 MINUTES PER AXIS. SINUSOIDAL VIBRATION - 5 - 35 HZ AT +/- 0.25 G PEAK IN THREE ORTHOGONAL AXES; DURATION CONTROLLED BY A ONE OCTAVE PER MINUTE SWEEP RATE. THERMAL VACUUM TEST WAS PERFORMED AT 1 PSIA MAX. TEMPERATURE WAS CYCLED BETWEEN -65 F AND +200 F AND LEAKAGE MEASURED; MAX LEAKAGE IS SCCM. OPERATING LIFE - 200 RELIEF VALVE CRACK/RESEAT CYCLES. ATP TO VERIFY LEAKAGE IS PERFORMED AFTER SHOCK AND VIBRATION TESTING.

IN-VEHICLE TESTING - RELIEF VALVE RESEAT TEST IS PERFORMED AT 15.25 PSID MINIMUM, 25 SCCM MAX LEAKAGE ALLOWED.

OMRSD - RELIEF VALVE RESEAT TEST IS PERFORMED BEFORE THE FIRST REFLIGHT OF EACH ORBITER AND AT INTERVALS OF FIVE FLIGHTS, AT 15.25 PSID MINIMUM; 25 SCCM MAX LEAKAGE.

(C) INSPECTION:
RECEIVING INSPECTION
RAW MATERIALS ARE VERIFIED BY INSPECTION FOR MATERIAL AND PROCESS CERTIFICATION.

CONTAMINATION CONTROL
CORROSION PROTECTION PROVISIONS AND CONTAMINATION CONTROL PLAN ARE VERIFIED BY INSPECTION. CLEANLINESS LEVEL 200A PER MA0110-301 AND 100 ML RINSE VERIFIED BY INSPECTION.

ASSEMBLY/INSTALLATION
BELLEVILLE SPRING FORCES AND TORQUES ARE VERIFIED. DIMENSIONAL CHECKS ARE PERFORMED BY INSPECTION. MIPS FOR CONCENTRICITY AND PERPENDICULARITY. VISUAL INSPECTION USING 10X MAGNIFICATION ON SEAL RING IS VERIFIED BY INSPECTION.

NONDESTRUCTIVE EVALUATION
BRAZING AND WELDING NDE CERTIFICATIONS ARE VERIFIED BY INSPECTION. X-RAYS OF BRAZES AND WELDS ARE VERIFIED BY INSPECTION.

CRITICAL PROCESSES
HEAT TREAT AND PARTS PASSIVATION ARE VERIFIED BY INSPECTION. LUBRICANT APPLICATION ON SEAL RING VERIFIED BY INSPECTION. POTTING VISUALLY VERIFIED BY INSPECTION. SOLDERING VERIFIED BY INSPECTION.

TESTING
ATP VERIFIED BY INSPECTION.

HANDLING/PACKAGING
HANDLING, PACKAGING, STORAGE AND SHIPPING PROCEDURES ARE VERIFIED.

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(D) FAILURE HISTORY:
SIX FAILURES HAVE OCCURRED:
AB4740-010, 8/13/79. IN TEST AT KSC, PPRV A POPPET FAILED OPEN. AFTER THE RELIEF VALVE HAD BEEN HELD OPEN BY GSE TO LEAK CHECK THE BUTTERFLY VALVE, THE RELIEF VALVE POPPET FAILED INTERNAL LEAK TEST. THE POPPET GUIDE MECHANISM JAMMED, HOLDING THE POPPET OPEN. NUT ON VALVE GUIDE STEM WAS FOUND TO BE NOT SEATED WHICH PERMITTED OVER TRAVEL OF THE POPPET. THE BUSHING AT THE END OF THE GUIDE STEM WAS SPALLED. CORRECTIVE ACTION - BUSHING I.D. CALLOUT WAS CLARIFIED TO SHOW I.D. AFTER NITUFF COATING. BUSHING AND TORQUE REQUIREMENTS WERE REVISED. LOCTITE CURE TIME REQUIRED PRIOR TO APPLICATION OF TORQUE FOR VALVE ADJUSTMENTS.

AB5186-010, 10/9/79. PPRV RESEAT PRESSURE FAILED IN TEST AT KSC. IRREGULARITIES WERE FOUND ON THE FLAPPER VALVE'S MOLDED SILICONE RUBBER SEAL. CORRECTIVE ACTION: ASSEMBLY PROCEDURES WERE REVISED TO REQUIRE VISUAL INSPECTION OF MOLDED LIP WITH THE AID OF 15/30 POWER MICROSCOPE IMMEDIATELY PRIOR TO ASSEMBLY INTO VALVE. ATP WAS REVISED TO ELIMINATE THE SUBJECTIVE METHOD OF CHECKING RESEAT PRESSURE BY OBSERVING A STREAM OF BUBBLES IN WATER. FLOW METER IS NOW REQUIRED FOR TESTING RESEAT PRESSURE.

AB8066-010, 11/5/80. IN SUPPLIER ATP, PPRV FAILED RESEAT TEST; RESEAT PRESSURE WAS 15.44 PSID, S/B 15.5 TO 16.0 PSID. REVIEW OF ASSEMBLY INSTRUCTIONS REVEALED THAT THERE WAS NO PERFORMANCE CHECK ON THE VALVE FROM THE TIME CRACKING PRESSURE WAS ADJUSTED TO THE TIME THE VALVE WAS SUBJECTED TO FORMAL ATP. POSSIBLE DISTURBANCE TO THE ADJUSTMENTS COULD OCCUR WHILE THE VALVE WAS BEING ASSEMBLED. CORRECTIVE ACTION - ASSEMBLY INSTRUCTIONS WERE REVISED TO ADD A PERFORMANCE CHECK OF THE VALVE AFTER FINAL ASSEMBLY, BEFORE ATP.

AC6225-010, 7/21/83, AT KSC. AFTER POPPET PULL TEST, PPRV A AND B LEAK RATES WERE IN EXCESS OF THE ALLOWABLE 25 SCCM MAX. THE VALVES WERE RETURNED TO THE SUPPLIER, WHERE CONTAMINATION ON THE POPPET SEALING SURFACES WAS FOUND TO BE THE CAUSE OF THE LEAKAGE. PARTICLES FROM THE CABIN HAD MIGRATED INTO THE VALVE PRIOR TO TEST. CORRECTIVE ACTION - CONTINUING EFFORT TO REDUCE CONTAMINANTS WITHIN THE CABIN.

AD0964-010, 4/23/86, KSC. PPRV A FAILED RESEAT AFTER HIGH FLOW TEST. VALVE WAS RETURNED TO THE SUPPLIER, WHERE A CONTAMINANT PARTICLE WAS FOUND ON THE SEAT. CORRECTIVE ACTION - DESIGN CHANGE TO REPLACE THE VALVE'S 6 MESH INLET SCREEN WITH A 75 MICRON NOMINAL FILTER.

AD1078-000, 4/10/86 AT KSC. PPRV B RESEAT LEAKAGE WAS 34.8 SCCM. SHOULD BE 25 SCCM MAX. VALVE WAS PURGED TO ELIMINATE POSSIBLE CONTAMINATION AND RETEST WAS SUCCESSFUL. NO CORRECTIVE ACTION.

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(E) OPERATIONAL USE:
~~TBS~~ IF POPPET IS LEAKING, CLOSE ASSOCIATED ISO VALV

- APPROVALS -

RELIABILITY ENGINEERING:	D. R. RISING	
DESIGN ENGINEERING :	K. KELLY	
QUALITY ENGINEERING :	M. SAVALA	2/8/91
NASA RELIABILITY :	JRB	4-2-91
NASA SUBSYSTEM MANAGER :		3/9/91
NASA QUALITY ASSURANCE :		3/4/91